

Model Components

Sept 20, 2001

Objective

- Given access to meteorological data, interpret numerical weather prediction products IAW an evaluation checklist.

Overview

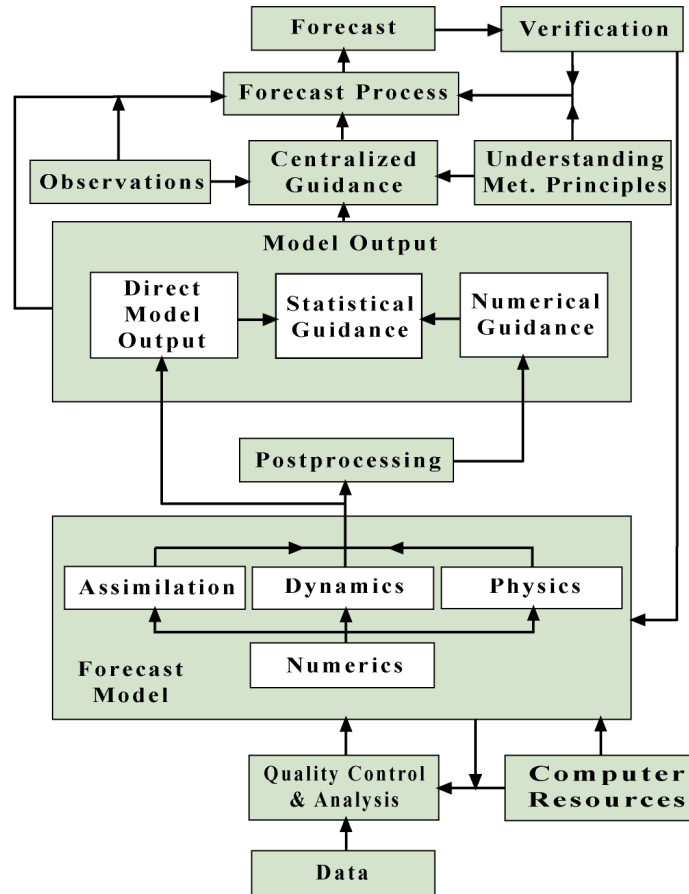
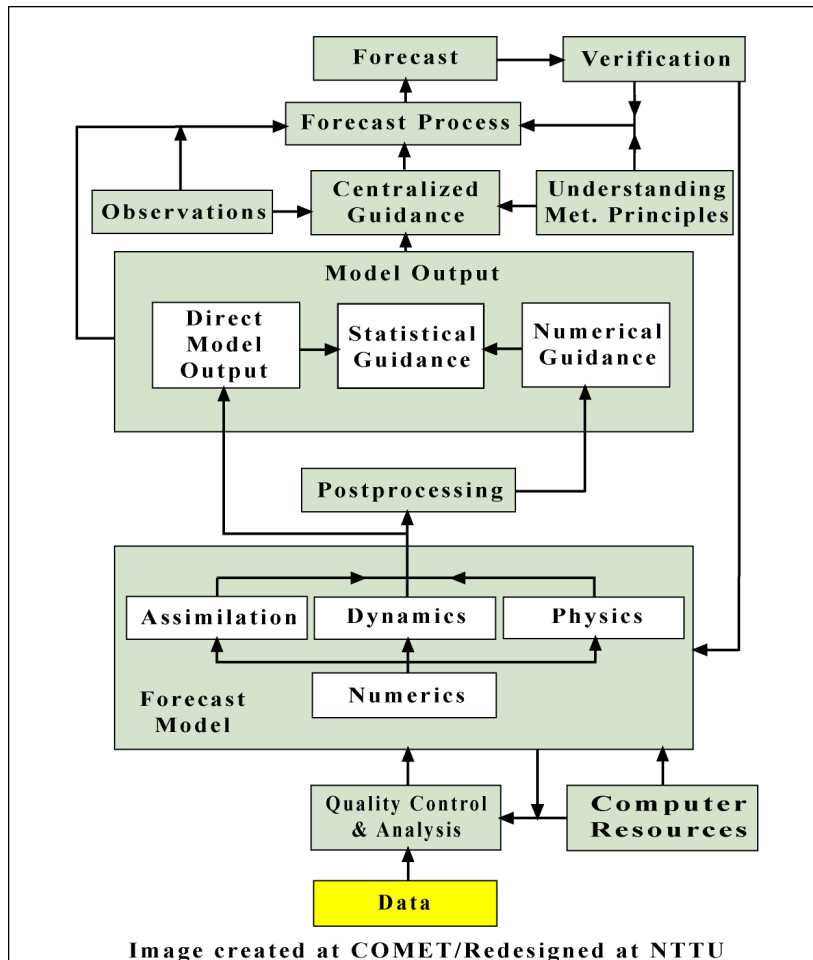


Image created at COMET/Redesigned at NTTU

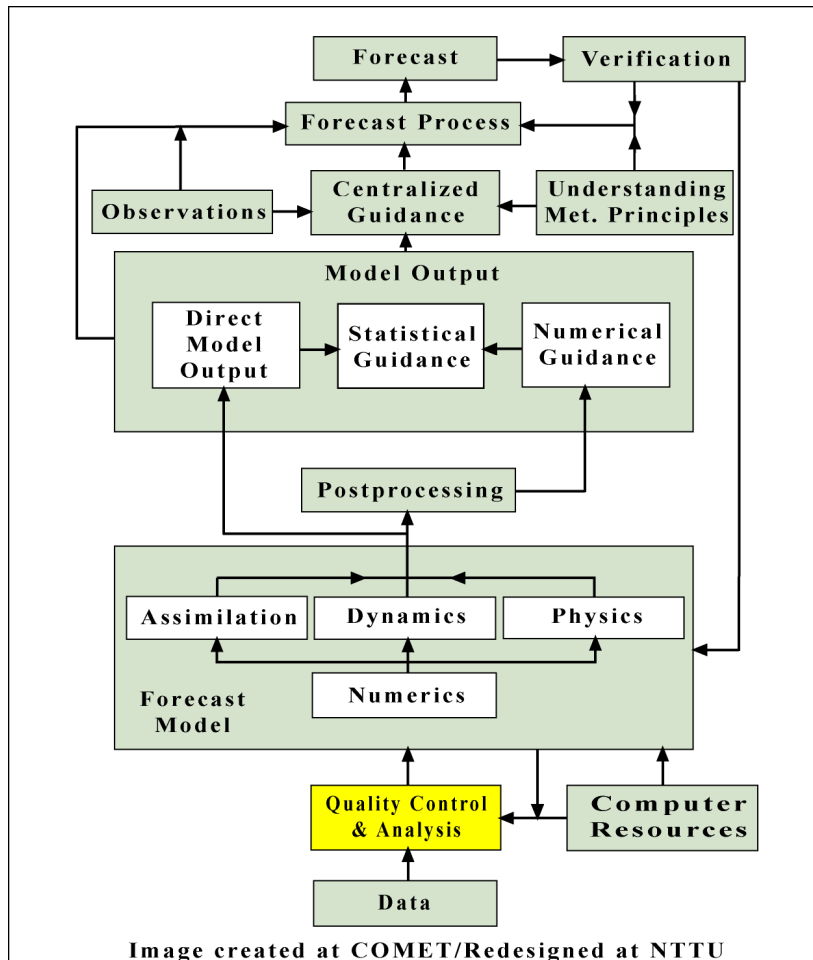
- 17 parts/steps in the processes of numerical weather prediction & proper model guidance usage

Data



- Used in determining the initial state of the atmosphere
- Data Source Examples
 - Satellites
 - Ground-based **Profilers**
 - Surface Stations
 - Upper-air Soundings
 - Radar
 - Aircraft Reports
- FNMOC **observations** count:

Quality Control and Analysis



- All numerical models usually perform some form of error checking to ensure the viability of input data
- NOGAPS, COAMPS, and ECMWF uses the three-dimensional variational (**3DVAR**) algorithm program for its error checking
 - 3DVAR is consider one of the best

Computer Resources

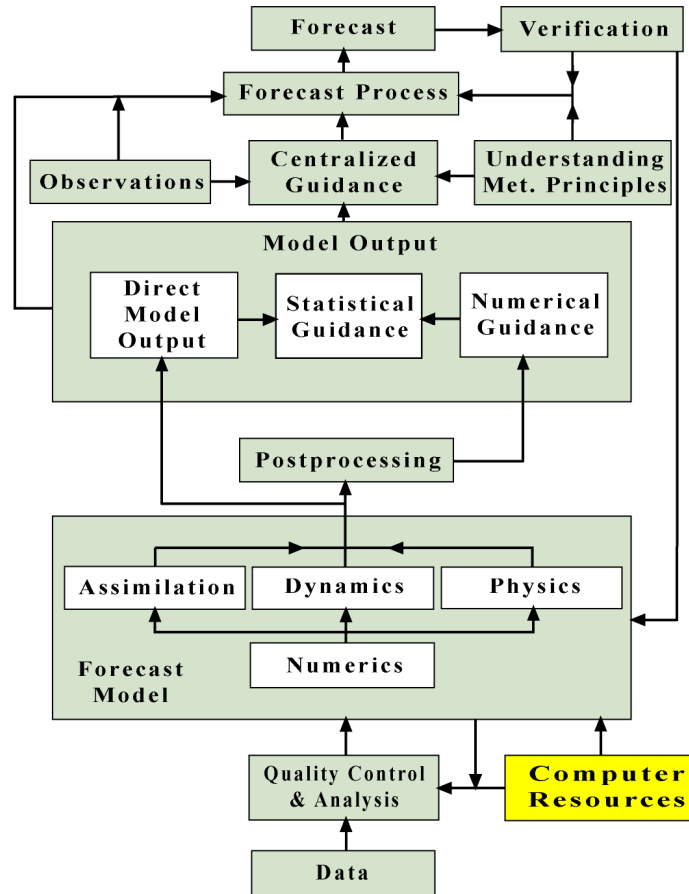
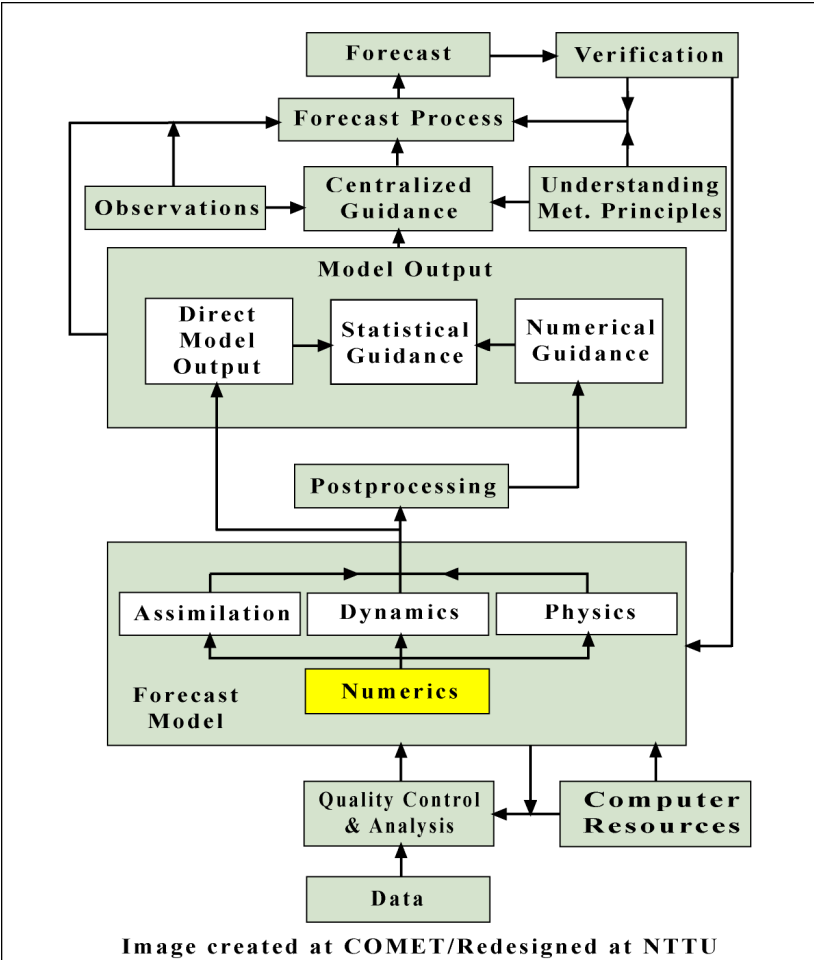


Image created at COMET/Redesigned at NTTU

- **Hardware** & software
- Computing resources govern the amount and complexity of the data and forecast model components used.
- A modeling center must find a balance between processing time and total cost.

Numerics



- Math formulas
- Data representation
- Model resolution
 - Horizontal
 - Data Sampling
 - Vertical
- Computation domain
 - Nested Models
- Coordinate system
- Models are not the same in the way they handle their numerics

Assimilation

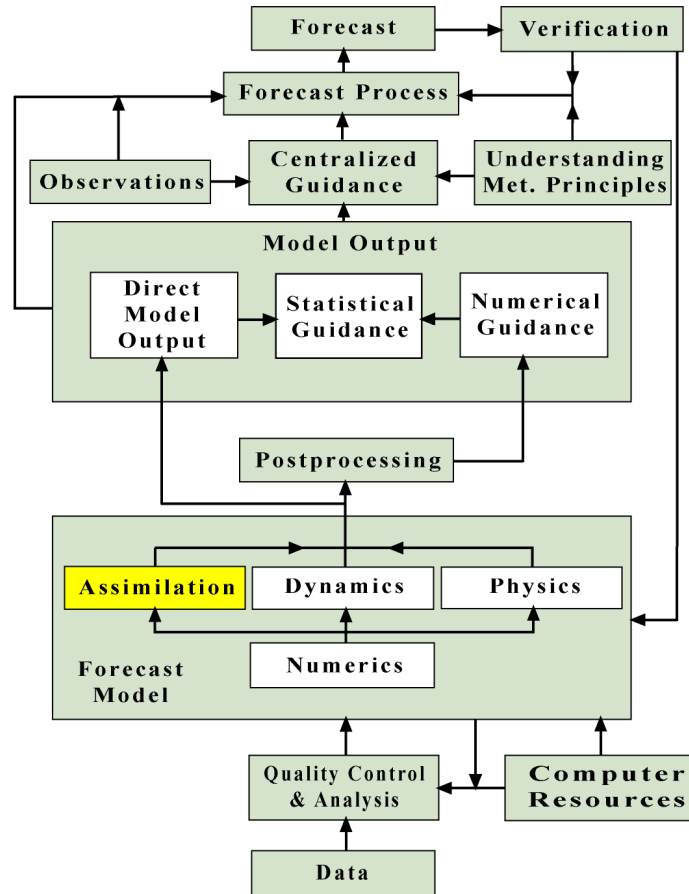


Image created at COMET/Redesigned at NTTU

- A system of procedures to convert input data to model variables.
- Blends this converted data with a short-range forecast from the previous model run.
 - This technique is referred to as a **WARM START**.
- This blending of previous model output and new data optimizes the accuracy.
- Not using a previous forecast is called a **COLD START**.

Dynamics

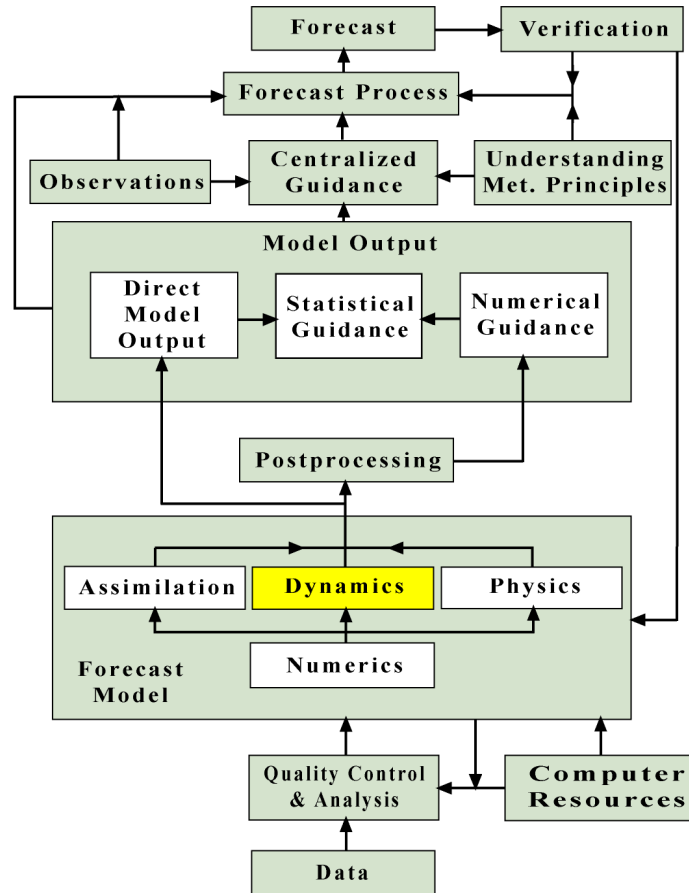
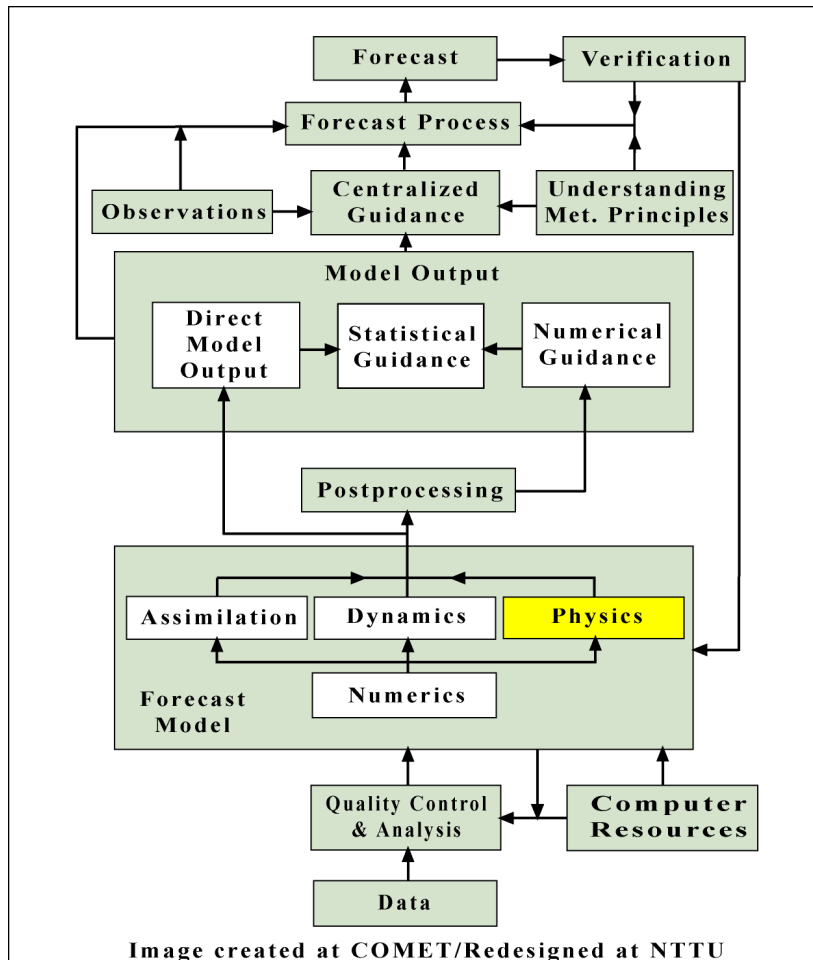


Image created at COMET/Redesigned at NTTU

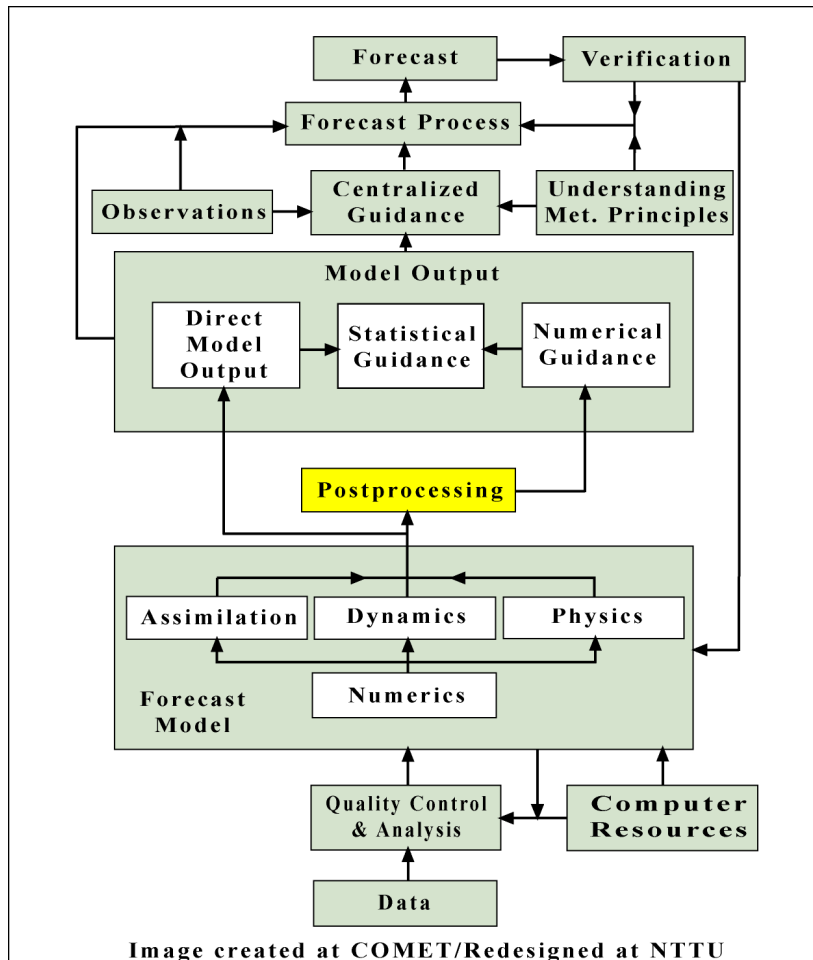
- Atmospheric processes that involve the forcing or movement of air, such as advection, pressure gradient forces, and adiabatic heating and cooling.
- These processes are described by a set of horizontal and vertical equations within the forecast model.

Physics



- In NWP, physical processes refer to three types of processes:
 1. Those operating on scales smaller than the model resolution but which exert a cumulative effect felt at resolvable scales
 2. Exchanges of energy, water, and momentum between the atmosphere and external sources
 3. Cloud and precipitation microphysics

Postprocessing



- Computations are made to the raw model output to transform it to a format readily usable by forecasters.
- Additional post-processing, such as using COAMPS-OS (On-Scene), WSI, AWIPS, and WXMAP may be done later. The resulting products are collectively referred to as numerical guidance.

Direct Model Output

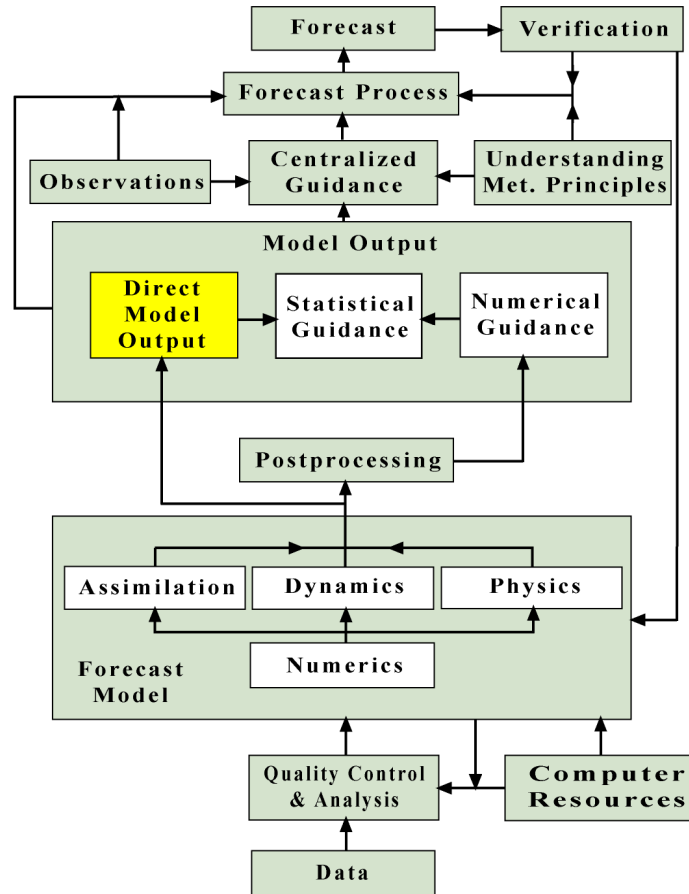


Image created at COMET/Redesigned at NTTU

- Refers to forecast data provided at each model grid point and vertical level
- These data are not interpolated for locations between model grid-points and levels
- Used by forecasters to develop local forecast and diagnostic products

Statistical Guidance

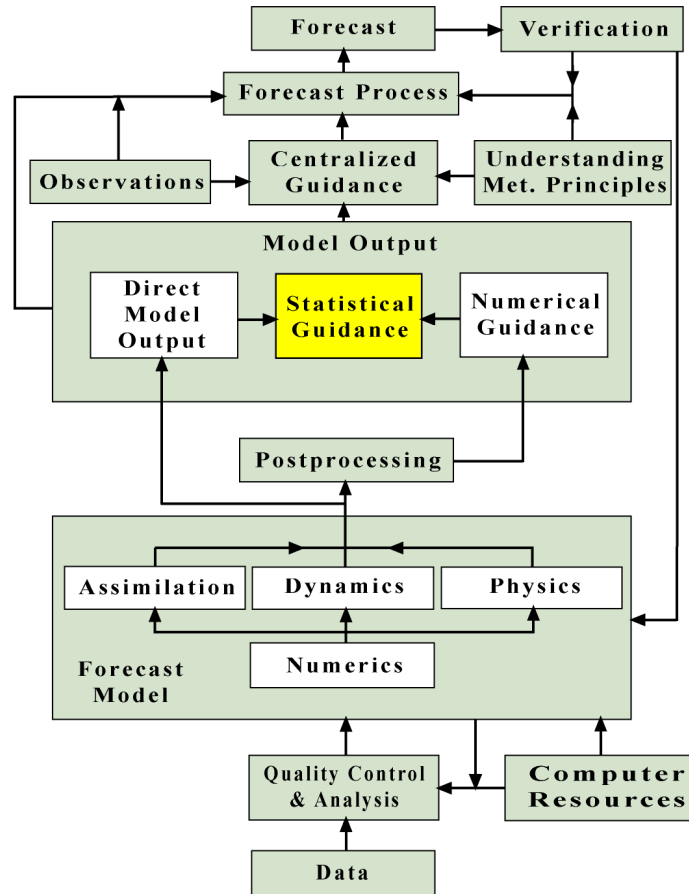
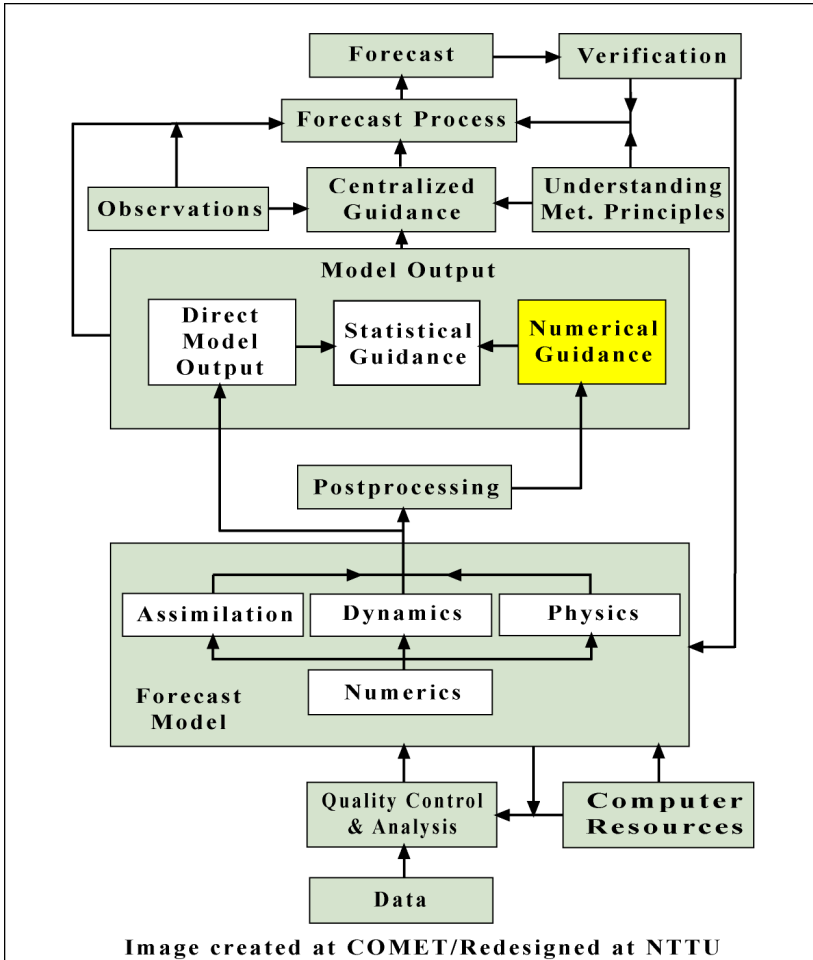


Image created at COMET/Redesigned at NTTU

- Statistical techniques, such as Model Output Statistics (MOS), have been developed to predict weather elements at particular point locations from direct and post-processed model fields and other pertinent data, including climatology.

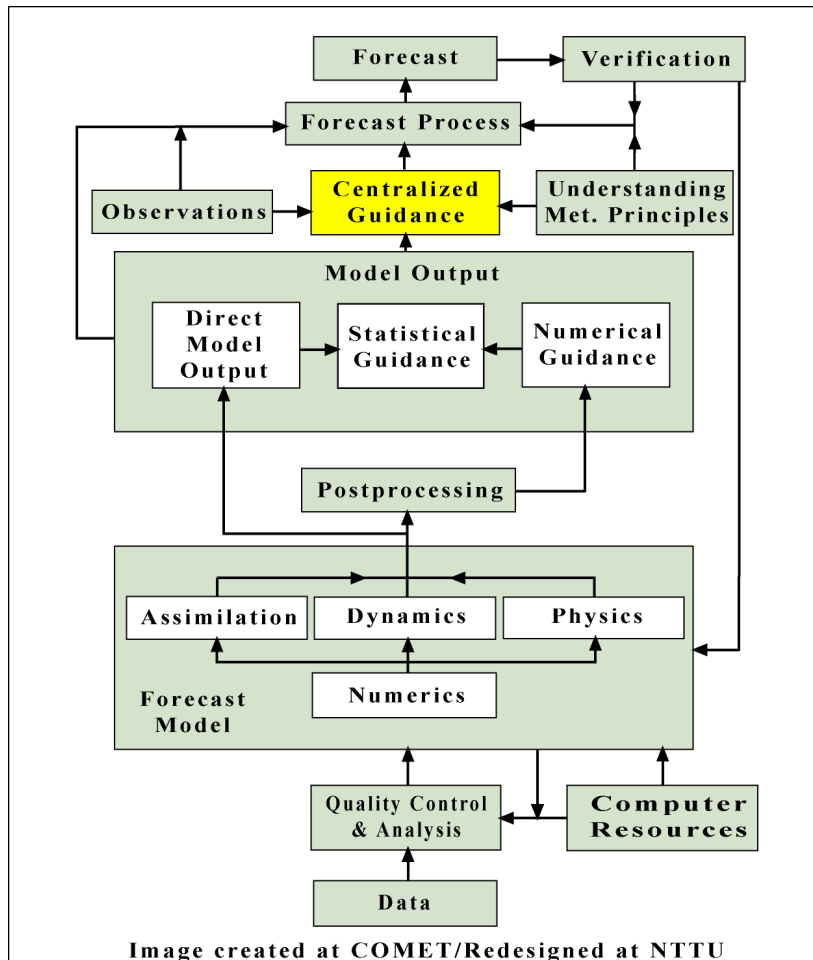
Numerical Guidance



- Numerical guidance products are produced through postprocessing of the model output. Examples:

1. COAMPS-OS Meteograms
2. COAMPS-OS Streamlines
3. JMV Viewing/Exporting
4. WXMAP
5. WSI

Centralized Guidance



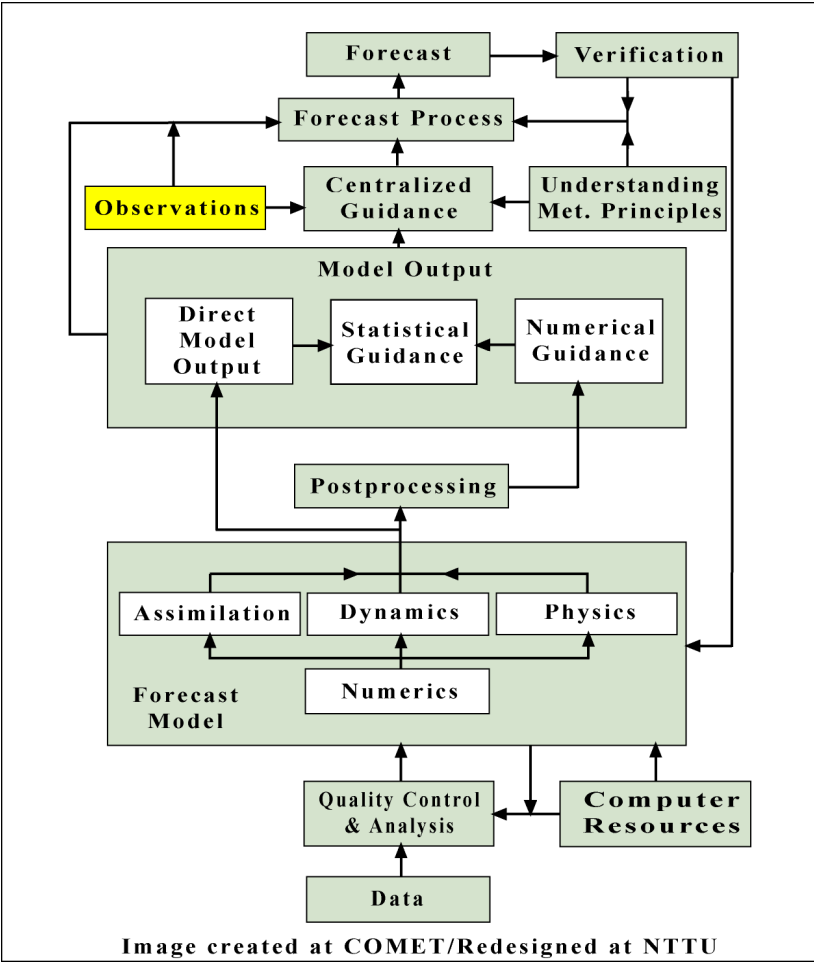
- Using all of the forecasting tools at their disposal, weather centers like NWS, AFWA, and NLMOC produce subjective, centralized guidance products. Examples:

- Hurricane track predictions
- Severe weather outlooks

- These products are added to the mix of tools and resources used by forecasters.

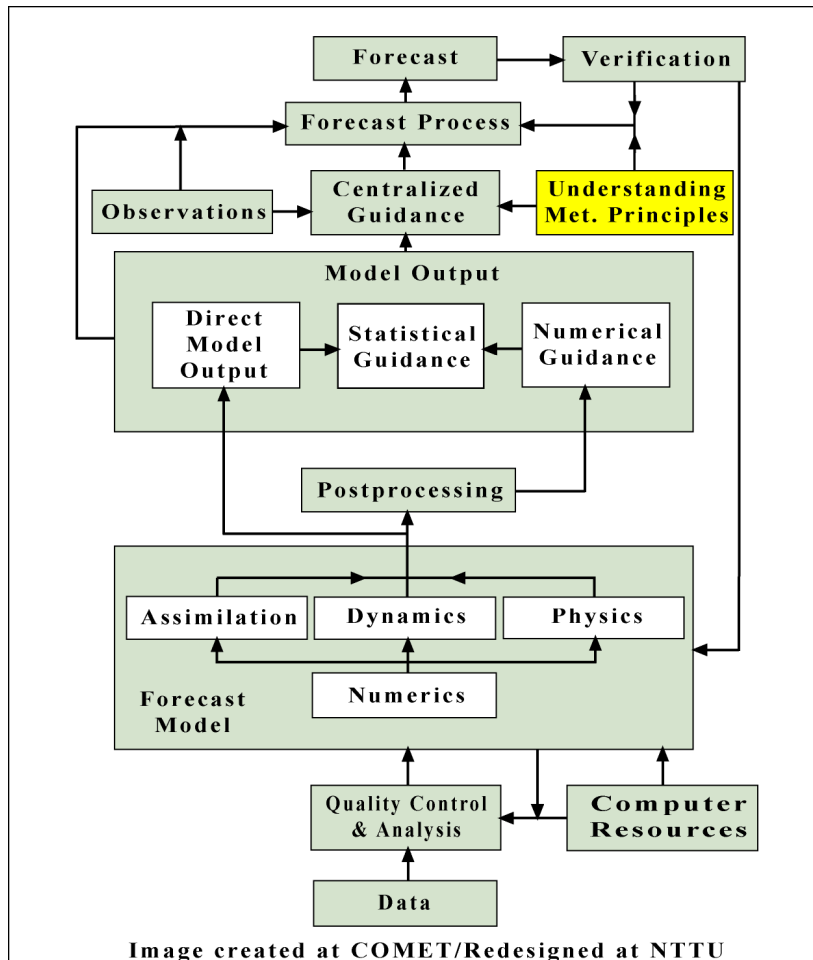


Observations



- Observations of all types are needed to ascertain current atmospheric conditions and to evaluate the accuracy of a model's analysis or forecast.
- Observations provide the ground-truth data and are used to help assess the reliability of model output and to make necessary adjustments.

Understanding Met. Principles



- An understanding of basic meteorological principles is necessary to intelligently use model guidance.
- For example, identify when model output is not meteorologically sound or consistent.

Forecast Process

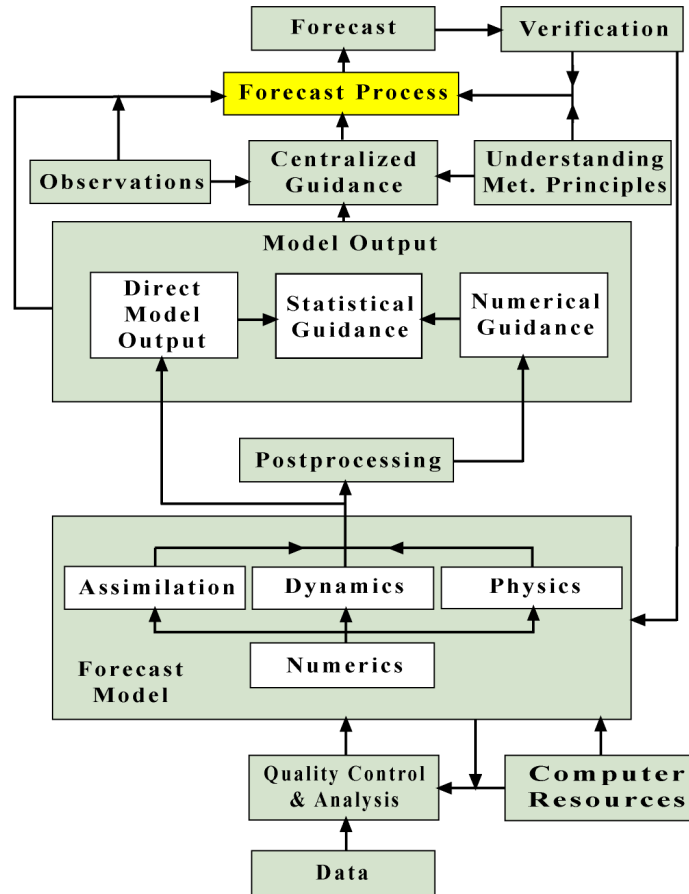


Image created at COMET/Redesigned at NTTU

- Model output and current observations are combined with the forecaster's understanding of meteorological principles to develop a forecast for the area of responsibility (AOR).
- Centralized subjective guidance is used to help with specialized aspects of the forecast.

Forecast

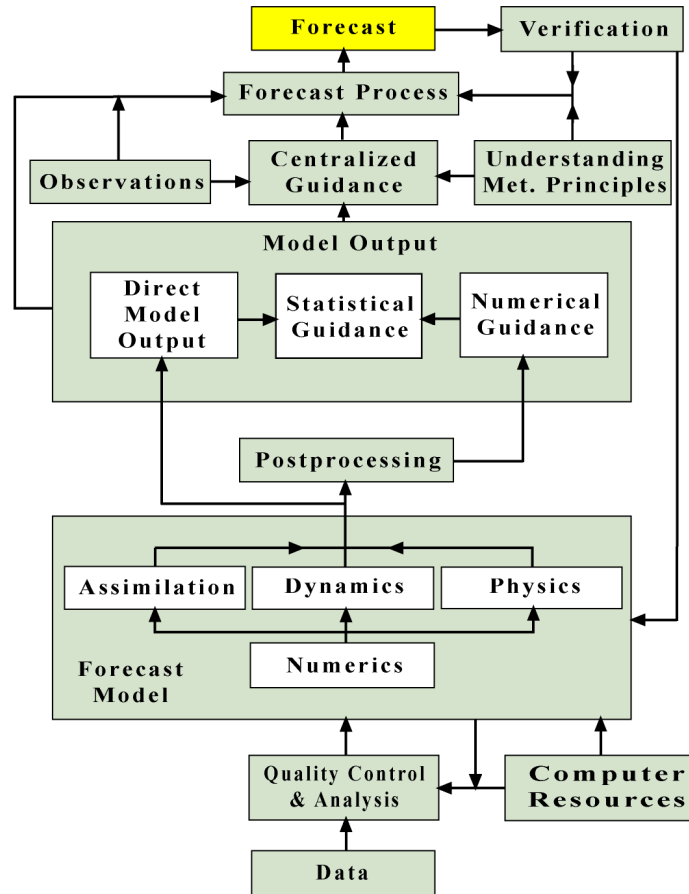


Image created at COMET/Redesigned at NTTU

- This represents the final product for which NWP was ultimately developed.
- The format, meteorological variables, forecast period, and frequency are driven by customer needs.



Verification

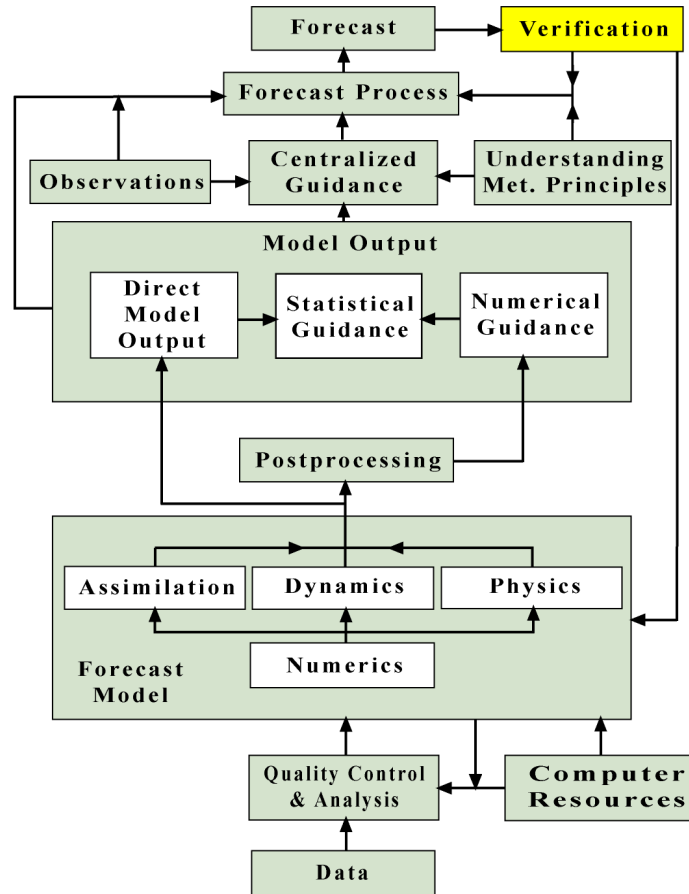


Image created at COMET/Redesigned at NTTU

- Forecasters use model verification data to identify specific limitations, statistical biases, and consistent **tendencies** of model guidance and to compensate for them.
- Modelers use verification data to help identify deficiencies so they can improve forecast model components.
- Model verification is an integral part of the NWP development process.

References

1. MetEd: Numerical Weather Prediction Unit 1 – *Model Fundamentals*
<http://meted.ucar.edu/nwp/pcu1/ic1/frameset.htm>
2. Naval Research Laboratory (NRL)
<http://www.nrlmry.navy.mil/>
3. Fleet Numerical and Meteorology Center
<http://fnmoc.navy.mil>
4. Naval Atlantic Meteorology and Oceanography Center
<http://www.nlmoc.navy.mil/>
5. Naval Pacific Meteorology and Oceanography Center, San Diego
<http://www.npmoc-sd.navy.mil/>
6. Air Force Weather Agency (AFWA) – *MM5 Introduction*
<ftp://ws-ftp1.afwa.af.mil/pub/aboutmm5/toc/intro/index.htm>
7. Joint Typhoon Warning Center Products
<http://www.npmoc.navy.mil/jtwc.html>

